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CONTENTS

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CHANCE AND THE PREPARED MIND[1]

("In the fields of observation chance favors only the mind which is prepared."—Pasteur.)

It was at the opening of the Faculté des Sciences at Lille on December 7, 1854, that Pasteur, only thirty-two years of age at the time, but already professor and dean of the faculty, uttered these words in upholding, in his inaugural address, the value, on the one hand, of practical laboratory instruction as an aid to the solution of industrial problems, and on the other the importance of investigation in pure science, even though the resulting discoveries might have no immediate application. The point of view may have been novel when it was uttered, but in the sixty years that have elapsed how familiar it has become. How closely it approximates the ideals of those who are striving to improve the conditions of medical education and of medical research in our own day and country. What better argument can the most ardent advocate of detailed practical instruction in laboratory or hospital (medical training at first hand) present, than that which Pasteur offered in 1854. He asks:

Where will you find a young man whose curiosity and interest will not immediately be awakened when you put into his hands a potato, when with that potato he may produce sugar, with that sugar, alcohol, with that alcohol, æther and vinegar? Where is he that will not be happy to tell his family in the evening that he has just been working out an electric telegraph? And, gentlemen, be convinced of this, such studies are seldom if ever

[1] An address on medical education, by Richard M. Pearce, M.D., University of Pennsylvania, delivered at Syracuse University, May 21, 1912, under the auspices of the Alpha Omega Alpha Honorary Medical Fraternity.

forgotten. It is somewhat as if geography were to be taught by traveling; such geography is remembered because one has seen the places. In the same way your sons will not forget what the air we breathe contains when they have once analyzed it, when in their hands and under their eyes the admirable properties of its elements have been resolved.[2]

Pasteur was a chemist, a physical chemist, if you will, and his illustrations were drawn from the realms of physics and chemistry, but if one substitutes for "electric telegraph" any piece of apparatus now in use in a medical laboratory or a hospital, the principle of the better type of modern medical instruction is embodied in his argument. He was talking to those who, after two years of practical and theoretical study, were to enter industrial careers as overseers and foremen in factories, foundries and distilleries. But neither time nor circumstance fundamentally alters the applicableness of his observations. After sixty years we may still urge his thought as the soundest of principles in the better education of men and women who are ultimately intended to enter careers as our overseers in matters of health and disease and as the foremen of public hygiene. Have our present-day medical schools succeeded in bringing to the training of their students the same practical and scientific thoroughness which Pasteur demanded for students in the industrial sciences and which students of the latter sciences now procure? If not, where lies the fault; in the college or the medical school, in the state or the public? Or are all more or less to blame? These questions will be discussed in due time, but first, let us turn to Pasteur's other proposition, investigation for its own sake. After stating his wish to be directly useful, personally and through his laboratory, to the industries of Lille, he says:

Without theory, practise is but routine born of habit. Theory alone can bring forth and develop the spirit of invention. It is to you specially that it will belong not to share the opinion of those narrow minds who disdain everything in science which has not immediate application. You know Franklin's charming saying? He was witnessing the first demonstration of a purely scientific discovery, and people round him said: "But what is the use of it?" Franklin answered them: "What is the use of a new-born child?"

Do you know when this electric telegraph, one of the most marvelous applications of modern science, first saw the light? It was in the memorable year 1822; Oersted, a Danish physicist, held in his hands a piece of copper wire, joined by its extremities to the two poles of a Volta pile. On his table was a magnetized needle on its pivot, and he suddenly saw (by chance you will say, but chance favors only the mind which is prepared) the needle move and take up a position quite different from the one assigned to it by terrestrial magnetism. A wire carrying an electric current deviated a magnetized needle from its position! That, gentlemen, was the birth of the modern telegraph. Franklin's interlocutor might well have said when the needle moved "But what is the use of that?" And yet that discovery was barely twenty years old when it produced by its application the almost supernatural effects of the electric telegraph!

This, gentlemen, may seem trite to you, for it is an argument oft repeated, but its significance, as far as medicine is concerned, lies in the fact that at the time Pasteur made these statements modern medical investigation was just beginning. The celebrated physiological institute at Berlin had been in existence only sixteen years; Schwann, following Schleiden, had elaborated the cell doctrine only fifteen years before and anesthesia had been practised for only six years. Claude Bernard was in the midst (1850–60) of his important discoveries concerning the pancreatic juice, the glycogenic function of the liver and the vasomotor system; three years were

[2] Vallery-Radot, "The Life of Pasteur," McClure, Phillips & Co., New York, 1902.

to pass before Virchow established (1855) the first pathological institute and as many again before this great master was to announce the doctrine of cellular pathology; and finally, it was thirteen years before Lister's first publication concerning the antiseptic treatment of wounds.

In all these activities and those which followed, the ideal of seeking for the truth no matter where it might lead—the ideal of pure science—was the secret of that wonderful progress which medicine has made in the last seventy-five years.

Now, however, it is time to return to our text, "In the fields of observation, chance favors only the mind which is prepared." What did Pasteur mean by "chance"? His meaning is very evident in his example of Oersted and the magnetized needle. The mind which is trained to observe the details of natural phenomena, and to reason concerning the bearing of known laws on such phenomena, is the "prepared mind," that is to say, it is a class of mind which, because it is endowed with a peculiar faculty, best described as scientific imagination—grasps the significance of a new observation, or of a variation from a known sequence of events, and thus establishes a new law or invents a new practical procedure. To no man perhaps is this adage of Pasteur more applicable than to himself. It was his work in chemistry and his studies in crystallography that gave him the "prepared mind" which correctly interpreted the significance of the chance observation that the presence of a vegetable mould, the *Penicilium glaucum,* in solutions of salts of the tartaric acids, changed an optically inactive to an optically active fluid. He grasped at once the true interpretation of this reaction. The disappearance of the dextro-tartaric acid, the permanence of the levo-tartaric acid, could be explained only by the assumption that the ferments of this particular fermentation "feed more readily on the right than on the left molecules." So did "chance" direct the "prepared mind" to those fundamental observations which established our present-day principles of fermentation, and which, as the result of work on alcoholic, acetic, lactic and butyric fermentation, led to Pasteur's final dictum:

> The chemical act of fermentation is essentially a correlative phenomenon of a vital act beginning and ending with it.

It was but a short step for the mind thoroughly familiar with the principles of fermentation to embrace the opportunity offered by the study of the etiology of the infectious diseases, and so through all his work, as that in connection with the silkworm problem, vaccination against chicken cholera and anthrax and the treatment of rabies, the "prepared mind" of the great master saw and appreciated the significance of every observation and every opportunity which presented itself.

Many other examples might be presented, as Semmelweis and his observations on the high mortality from puerperal sepsis among those under the care of students fresh from the dissecting and autopsy room and the low mortality among patients under other supervision. So also Lister and his antisepsis; and best of all, perhaps, for purposes of illustration, the sequence of Ehrlich's discoveries. We are told that in his student days Ehrlich was interested above all other things in the study of chemical affinities and worked incessantly with the new anilin dyes. Indeed the story goes that so engrossed was Ehrlich in his work that neglect of the required studies gave rise to some question concerning his right to receive his degree. The situation as described by Christian A. Herter[3] was as follows:

[3] Herter, C. A., "Imagination and Idealism in the Medical Sciences," *Jour. Am. Med. Asso.,* LIV., p. 423, 1910.

Although at this time Ehrlich was especially under the direction of the anatomist Waldeyer, he rapidly developed a capacity for chemistry which was a surprise both to himself and to the chemist, Adolf von Baeyer, whose lectures had been systematically cut by the gifted but unconventional student. For unconventional he then was, and ever has been, neglecting what he did not like and throwing himself with fervor and intense energy into the solution of the themes that attracted him. From the outset it was clear that Ehrlich would make a career as an experimental investigator. Much of the time he was supposed to spend in taking the usual medical courses he devoted to experiment. When Robert Koch was shown through the laboratory at Breslau by one of the professors, his attention was called to a young student working at a desk covered with bottles of dyestuffs. "There is our little Ehrlich," said the professor; "he is a first-rate stainer of tissues, but he will never pass his examinations." The prediction about the examinations came perilously near fulfillment; Ehrlich made bad flunks and it is hinted that he never would have received his degree had he not made a discovery—namely, the existence of the peculiar type of leucocyte which is known to us as the "plasma-cell." The faculty reasoned that it would be improper to keep so promising and original a worker indefinitely in an undergraduate position, and it is suspected that they mitigated the rigor of the examinations in order to relieve their own embarrassment.

These early studies were doubtless responsible for what must be considered as the main theme of all Ehrlich's work—the specific affinity which exists between specific living cells and specific chemical substances. The "prepared mind" is evident in his study of the cells of the blood, of the selective action of methylene blue on the nervous system, of the use of the same dye in the study of oxidation and reductions occurring in tissues, of his studies in immunity, of the specific treatment of protozoan disease, and also according to recent reports in his application of the same principle to the study of cancer. Manson's studies of the relation of the mosquito to filariasis, which led to Ross's study of the transmission of malaria by the same insect, is another example of the "prepared mind" properly interpreting a chance observation. Sometimes such discoveries are referred to as the result of scientific imagination—and it truly is this—but doubtless the same "chance" came to many besides Pasteur, Ehrlich, Laveran, Koch, Theobald Smith, Manson, Ross and Reed; it was the training of these individuals, the mind prepared to utilize scientific imagination, that enabled them to grasp the opportunity offered by "chance" observation. Every one familiar with the history of investigation in medicine knows that before Harvey, men studied the circulation; that before Pasteur, bacteria were seen in diseased conditions; before Lister, the effect of cleanliness upon surgical mortality had been noticed; before Laveran, the plasmodium of malaria had been seen; before Manson and Ross, the possibility of the transmission of malaria by the mosquito had been discussed. Truly,

remarkable achievements are never unique occurrences in nature. Even the greatest men rest on the shoulders of a large multitude of smaller ones who have preceded them, and epochal discoveries emerge out of a period of intellectual restlessness that affects many minds.[4]

But of these minds, it is that one which is "prepared," trained in the methods of observation, therefore possessing the priceless quality of scientific imagination, which sees the proper block which when placed exactly where it belongs completes the edifice of a perfect theory, and thus establishes a new landmark for future progress.

But what, you ask, has all this to do with the training of the physician? How does it apply to medical education? We admit the value of these qualities in the investigator, but of what value are they to the man seeking the education necessary to

[4] Flexner, S., "The Biological Basis of Specific Therapy," Ether Day address at the Massachusetts General Hospital, October 16, 1911.

practise medicine? Let me repeat Pasteur's adage—"In the fields of observation, chance favors only the mind which is prepared." Certainly all will agree that medicine is largely an observational science and one of the "fields of observation" of Pasteur's definition. Medicine may not be all science, but clinical medicine in its most essential phase—diagnosis—is essentially a science of observation, either of direct observation by the use of the unaided senses or indirect by the use of instruments of precision, or by chemical, biological or other tests. Therefore, whatever force or whatever lesson this adage may carry, applies to medicine. And now as to the interpretation of "chance." I have not been able to obtain the original French of Pasteur, but from his parenthetical phrase in connection with the discussion of the telegraph it is clear that he meant exactly what the translator has given us, chance or opportunity in the sense of an unexpected observation or an accidental occurrence. Pasteur's idea was that such unexpected or accidental occurrences would not arrest the attention of the poorly prepared mind, but that the well-prepared mind, trained to observe, to think and to compare, would grasp the significance of the unexpected, the unusual or occasional, put the observation to the test, by experiment or control, and arrive at the correct conclusion. Is not this a matter of daily occurrence in clinical medicine? Does not chance (opportunity some would call it) and care in details play an important part in diagnosis? Is not every ailment the physician sees a puzzle; every diagnosis, if correct, a solution of that puzzle? One speaks of the man who solves the puzzle which has baffled half a dozen other men, as a keen or accurate diagnostician. They imply that he has an added power, or that his skill is the result of wider experience, forgetting they may have seen as many individuals with the malady as had the consultant, and perhaps totally ignorant of the fact that his diagnosis was possibly based on a chance observation which meant more to his trained imagination than it did to minds unaccustomed to weigh the significance of details. Every clinician of experience can give examples of the importance of chance and imagination in actual diagnosis. An interesting illustration is that

> of the two students who reported on the same patient in competition for a clinical prize. The patient presented, among other symptoms, a remarkable discoloration of a certain area of skin, and the first student described this discoloration with the most careful minuteness. He measured it in different directions and drew a rough sketch of its general outline. The second observed the phenomenon with equal care, but he exercised his imagination and formed a hypothesis which he proceeded to put to the test. He asked a nurse for a wet towel, with which he wiped the discoloration away. It is evident that the faculty which he thus brought to bear on the problem before him would be likely to stand him in good stead in relation to many others of a more complicated character; and that his exercise of the art of diagnosis would be practically immune from the errors incidental to the habit of taking all appearances at their face value. Imagination at once points to the possibility of more than one explanation of any given occurrence, or alleged occurrence, and compels inquiry as to the existence of probable causes beyond the particular one which may at first sight appear to have been in operation.[5]

From what has been said, then, it should be evident that it is the first duty of a medical school to prepare men properly for the practise of medicine (and the most ardent advocate of research in the university will not deny that this is the first duty). If so, what are, conditions to be fulfilled to ensure the "prepared mind" of Pasteur's adage?

The Preliminary Education of the indi-

[5] "Imagination in Medical Research," *Lancet*, 1912, CLXXXII., 179.

vidual is the first and in many ways the most important consideration. I know it is bringing coals to Newcastle to discuss this question before the students and faculty of Syracuse University, for you have been among the first to recognize the value of two years' college work which shall include physics, chemistry and biology. Still this principle is not generally recognized. Many of those in positions of authority in our medical schools, while loudly proclaiming the right of medicine to a place among the sciences and indeed characterizing it as the "Mother of the Sciences," deny that a scientific education is a prerequisite to medicine. True, the opposition is frequently due to a realization of the awkward financial position in which an administration might be placed if students' fees diminished. Frequently also it is due to the claims of those who hold that a greater cultural value lies in following the humanistic rather than the scientific school of thought. Naturally, there is also the "poor boy cry" and the closely associated cry that outlying districts will not be properly cared for if the cost of medical education is increased. The "poor boy" argument may be dismissed at once, for those who have had experience in teaching medicine know that the boy, poor or otherwise, who knows what he wants in the way of an education, gets that education in spite of all difficulties, and as a rule, if he has to work for it, is keen enough to get the best that is to be had. Such men will "come through" despite all apparent barriers in the way of higher preliminary requirements; if the indifferent "poor boy" fails, lacking ambition and a clear conception of what he wants, so much in favor of the higher requirements.

As to the outlying districts, we need have no fear as long as the ratio of physicians to population is 1 to 568[6] and the use of the automobile is increasing. If the ratio should change greatly, which does not seem likely, for only two states[7] (North and South Carolina) have a ratio of less than 1 to 1000, the matter then becomes one for state regulation, for, as the report of the Carnegie Foundation has shown, we have enough physicians, but the difficulty lies in the tendency of physicians to seek the larger civic centers.

With the discussion of the cultural value of humanistic as compared with scientific studies, we are not concerned. It is sufficient that in a university medical school a man can not properly study modern medicine without that knowledge which comes from a familiarity with laboratory work in physics, chemistry and biology. The value of biological training for those interested in practical medicine was emphasized by Huxley many years ago, and that in physics and chemistry has recently been emphasized by Friedrich Müller[8] in describing, for the benefit of the English Commission, the training of the German medical student.

> During his first and second year,[9] the medical student attends lectures and does laboratory work in physics, chemistry, botany and zoology in the philosophical faculty, and he has the opportunity of widening his views by listening to lectures on philosophical or historical subjects. His teachers and laboratories are the same as for the students of the natural sciences, and this is right, because there is no such thing as special medical physics

[6] Flexner, A., "Medical Education in the United States and Canada," Bull. No. 4 of the Carnegie Foundation for the Advancement of Teaching, 1910.

[7] *American Medical Association Bulletin*, 1910, V., 278.

[8] Müller, F., "Memorandum on Medical Education Submitted to the Royal Commission on University Education in London."

[9] The German student seldom takes his state examination until the end of five and a half years' work (Müller).

or chemistry; the physician requires a broad knowledge of the general sciences of physics and chemistry.

It is most important to have this statement of Müller's at a time when an effort is being made to place physics, chemistry and biology in the medical curriculum. With or without a fifth year it is a dangerous policy. The experience of one school in this regard is enlightening. During the period of change from a high school to a two-year college requirement, conditioned men were cared for by allowing time in the first half of the first year to make up conditions. The procedure took eighteen hours a week from the time which should have been devoted to purely medical studies. In such an emergency as that of a change of policy, this was perhaps justifiable, but what university school with a four-year course can afford this arrangement as a permanent policy? And if we are to have a fifth year, progress demands that it should be a clinical or hospital year, and not a preliminary year for work which belongs to the college. The modern curriculum of a first-grade medical school demands a student's full time and attention and no amount of general culture can make up for absence of prerequisites in physics, chemistry and biology. The school which allows mixed requirements, or low requirements or conditions does so at the expense of efficiency; the good men suffer on account of the slow progress of the poorly trained; the inefficiency of the teaching under such circumstances becomes noised about, and it comes to pass that the best-trained men go to schools which take only their kind, and thus eventually low standards react on the school allowing them.

But this is not all. Another factor, the state, is beginning to play an important part in determining the conditions prerequisite to medical education. Five[10] states have passed laws demanding that for license to practise medicine an applicant must have had two years of college work as a minimum requirement, and four[11] demand one year. This, we must admit, is only the beginning. As state after state adopts the same ruling, schools not demanding such preparatory study must see the territory open to their graduates (and therefore the territory from which they draw students) gradually narrowed. Certainly, to-day, no school, and certainly no university school, can face with equanimity, this discrimination; and "disappointed indeed will be that student who, after having spent a large amount of time and money, finds on graduation that his diploma is not recognized in a large number of states."[12]

Methods of Teaching.—Within the medical school itself the matter of educational policy is clear. Here there can be only one procedure, the constant and consistent employment of the "do it yourself" or "learn by doing" method; the student must be taught to observe, experiment, reason and act for himself. This, I know, is trite, but the conditions out of which our present methods of medical education have emerged demand that this point of view be continually emphasized. It is not long since the day of the two- and three-year course and the imparting to undergraduates of all medical instruction, outside of anatomy and inorganic chemistry, by lecture. The development of the laboratory branches, histology, pathology, bacteriology, physiological chemistry and pharmacology—and the cheapening of physiological apparatus

[10] Colorado, Indiana, Iowa, Minnesota and North Dakota.

[11] Connecticut, Kansas, South Dakota and Utah.

[12] *Jour. Am. Med. Asso.*, LVII., p. 1138, 1911; LVIII., p. 487, 1912.

—have given a new turn to medical teaching, that of active participation by the student. But still even in these branches the lecture still persists in most schools and frequently is so magnified in connection with the laboratory instruction as to make it appear in the eyes of the student as the most essential part of the course. The advance in methods and means of practical laboratory instruction—that is, the visible machinery for developing the principle of teaching by actual observation and experiment—would seem in some schools to be an equipment for advertising purposes only. One does not have to go outside the group of our so-called "big" schools to find a department of pathology, abundantly equipped with apparatus and a wealth of pathologic material, offering five lectures a week; and one may find an elaborately equipped student's laboratory of physiology manned by assistants while the head of the department fulfills his duty to his class with three or four lectures a week; and likewise, in the clinical branches, few men have had the courage to do away with frequent and voluminous lectures. Even schools controlling a large hospital, and sometimes several, and thus having an abundance of clinical material, do the bulk of their teaching by the formal lecture and the amphitheater clinic. The ward class and the clinical clerk system gain ground but slowly. The reason for this attitude is easily found. The lecture is the easiest form of teaching, and the average teacher, whether he be the laboratory man overburdened by executive detail and handicapped by lack of assistants, or the clinical teacher limited in time by a busy practise, follows the lines of least resistance, forgetful, though sometimes resentfully so, of the best needs of his class. Usually coexistent with a pernicious lecture system is the habit of leaving those most favorable fields for proper education—the laboratory exercise and the ward or dispensary class—to assistants. No one has less desire to belittle the work of assistants or to lessen their independence than have I, but in the department in which the head lectures only the student naturally assumes that the work of subordinates—in laboratory or clinic—must be work of subordinate importance, and thereby he comes to have a wrong estimate of the live part of his education. The most ardent supporter of the lecture system can not say that he always holds the interest of his class. He may hold their attention and be flattered by copious note-taking, but this has for its object only one purpose—the final examination. The real education—the training which means power and which characterizes "the mind which is prepared"—can come only through independent but wisely directed observation, experiment and reasoning on the part of the student.

I have discussed elsewhere[13] how the latter system may be fostered, and am now glad to be able to reinforce my position by quoting from the recent very excellent address on this subject by Professor G. M. Jackson.[14] As to the share of the teacher Professor Jackson says:

> It is evident that each teacher must understand the curriculum as a whole. The laboratory man must be familiar with the clinical work. But this is not all. Since good teaching must take into account that which has gone before as well as that which is to follow, it is equally evident that the clinical man must be familiar with laboratory subjects and methods. We can not expect the best results in medical education until there is a better understanding and more cooperation between teachers of the various subjects all along the line.

[13] Pearce, R. M., "The Experimental Method: Its Influence on the Teaching of Medicine," *Jour. Am. Med. Asso.*, LVII., p. 1017, 1911.

[14] Jackson, G. M., "On the Improvement of Medical Teaching," SCIENCE, XXXV., p. 566, 1912.

As medicine progresses, all phases appear more clearly as varied manifestations of the same underlying biological science, and only when this is realized will the clinical and laboratory work be more closely knitted together.

As for the student, it is suggested that he

work out everything for himself by the method of discovery. This applies not only to the original observations, but also to the latter process of reasoning, whereby we proceed from particular data to general conclusions, and thence to rational action. The method of self-activity may therefore be expressed in a negative way by the following practical rules: Never tell a student anything he can observe for himself; never draw a conclusion or solve a problem which he can be led to reason out for himself; and never do anything for him that he can do for himself.

There are, of course, limitations to the application of this method, as lack of time, an overcrowded curriculum, inability on the part of the teacher to fully grasp the situation, and failure to always maintain sustained effort on the part of the student, but its value over the lecture system is so great that it should be followed in "so far as practicable" (Jackson) and should be supplemented by demonstrations and conferences or recitations rather than by lectures, if one truly seeks to prepare properly for the practise of medicine.

Influence of the Spirit of Investigation.—But aside from this training the university has another duty to the prospective practitioner of medicine. This is its duty in the encouragement of investigation, which is indeed a double duty, a duty to its students and a duty to the community it serves.

The question of allowing undergraduates to undertake independent original investigation is, I know, a debatable one. Certainly in most schools our overcrowded curriculum renders such work impossible unless a wise arrangement allows elective studies, as at Harvard in the fourth year, or as at Johns Hopkins in each year. My remarks on this subject are therefore based on the assumption that an elective system is possible in every school.

As every teacher knows, each class contains a considerable number of men who desire to pursue work, to a greater extent than the conventional course allows, on certain subjects or by special methods, or less frequently, perhaps, they desire, and are usually well qualified to undertake, minor investigative work. To the former, as well as to the latter, any effort spent in work beyond that given the entire class becomes, necessarily, for them, the acquirement of the methods of research and as this means a knowledge of the exact, painstaking methods by which the realms of the unknown are explored, it is an exercise which prepares the student for the daily routine research work of the physician who truly practises his profession. As a training for future work, its value is definitely known and the increased zest and enthusiasm exhibited toward their medical work by men who have had this opportunity are always evident. Pedagogically, therefore, it would seem advisable that every student should have the opportunity for minor investigative effort, in order that he may become acquainted at first hand with the careful methods of experimental medicine. The bearing of the tangible results of his work on the subject investigated is a matter of little or no importance; the vital thing is the increased power which he himself acquires.

There is another way in which the encouragement of research aids the student, but which is possible only to those schools following the wise policy of appointing to professorial chairs, teachers who are likewise investigators. The influence of such teachers in the development of independent and resourceful practitioners is the secret of the great success of our better schools.

The correctness of this statement may be easily demonstrated.

If one examines courses in the same subject in a number of schools it is found that those which are best presented are under the control of men actively engaged in research work. Such men are alive to the advantages of new methods in their own subject and of new ways of applying old methods. Ever thinking and pondering about new methods of acquiring knowledge for themselves and their science, they appreciate better than does the non-investigator, that which will aid the student to acquire knowledge, and in their teaching they bring to bear on the problems which the student has to face the same methods of attack which they use in their own researches. On the other hand, one finds the men who never or only occasionally contribute to the literature of their science are the men who confine their teaching to perfunctory routine courses, with a profusion of lectures, and who never bring the spirit or methods of the investigator into their teaching. So, likewise, it is with the student taught under these two conditions. The student who knows that he is working in a department actively emphasizing new methods and striving to develop new truths, knows that his instruction is presented in the spirit of the department, and thus receives that stimulus and inspiration which insures his approaching clinical medicine with a proper appreciation of the scientific method. The student under the method of the non-investigator, on the contrary, has no incentive other than that of acquiring a knowledge sufficient to allow him to pass an examination.

An allied argument lies in the fact that the medical school that fosters research attracts the best-trained men as students. We have, as is well known to many of you, a medical school in this country which has, for several years, arbitrarily selected from a large number of prospective matriculants the certain definite number which it desires; the rest, sometimes nearly fifty per cent. of those accepted, go elsewhere. Now this school has the highest requirements and perhaps the smallest alumni body of any prominent school in the country. It is not, therefore, a question of easy entrance or of the loyal influence of alumni, nor is it a question of better laboratory and hospital facilities, for other schools have equally good equipment in both respects. Likewise it is not a question of geographic location or center of population. The enviable position of this school is due solely to the policy of combining research with teaching and of appointing to its staff teachers who, with few exceptions, are also investigators.

As to the duty of the university to the community in the matter of research, there can be only one opinion. If the purpose of the machinery of medical education is to "bring healing to the nations," if the business of medicine is to "get people out of difficulties through the application of science and dexterity, manual and physical" (Cabot), then it is the duty of the university not only to teach known principles and methods, but to advance knowledge and methods by research.

It is futile to say that it is sufficient to teach and to utilize known methods of freeing people from difficulties, for the mere statement of such an attitude implies that an obligation exists to extend known methods, or to invent new ones, in the hope of overcoming difficulties acknowledged to be at present without remedy. The ethical force of this statement can not be denied. To teach a subject implies the attempt to diffuse the available knowledge of that particular subject matter among a number of people for their good, as well as for the good of the community in which they live

and work; equally true is it that such an attempt to teach available knowledge imposes upon the teacher the obligation to leave untried no means by which the knowledge of his subject may be increased. It is not the privilege of the teacher to leave this extension of knowledge to others. His profession of ability to teach a particular subject carries with it his obligation to the group or community he serves, of adding to his subject knowledge of which they may avail themselves. If this applies to the individual teacher, how much more forcibly does it apply to the university with its ever-widening community and ever-increasing interests?

On the other side of the question, the university should not forget that medical research tends to ameliorate social conditions by diminishing the causes of physical and mental ills. This ideal of medicine the university and its community should foster and develop, for it is one of the greatest influences in our modern conception of social service; an influence indeed which was back of all Pasteur's work, and which he expressed in the statement of his desire to contribute "in some manner to the progress and welfare of humanity."

But aside from this altruistic ideal, I hold that research in the medical school offers important practical advantages to the university and that these advantages should not be forgotten by university authorities, who pride themselves on applying business-like methods to the problems of education. A policy which attracts a better-trained class of students, which improves the character of the instruction, which stimulates the student to a better type of individual effort and which enhances the standing of the university in the community and the nation is a policy which can not be ignored by university president, trustees or faculty.

The Relation of the Hospital to Medical Teaching and Research.—That the laboratories of our better medical schools are fully equipped for the kind of instruction which I have outlined, and that many are already fostering the "do it yourself" principle and the spirit of investigation is well known. In the clinical years, on the other hand, the situation is not so satisfactory. Many a medical school while building and equipping modern laboratories has failed to care properly for its clinical teaching, and has continued to foster the amphitheater lecture. If the method of first-hand instruction, which I have outlined, is to be followed, then the hospital must become the laboratory of the clinical years and a school must own or absolutely control its hospital. This is necessary in order (1) that the heads of the clinical departments may have a continuous service under their immediate charge and to the conduct of which they may bring their own assistants; (2) that in connection with such service they may develop laboratories for teaching and research in addition to the usual clinical laboratory now used only for purposes of diagnosis; and (3) that resident physicians may be appointed for indefinite service in order that trained teachers and investigators in clinical medicine may be produced in the same way as trained teachers and investigators in the laboratory branches are now produced, and (4) that the head of the department may provide adequately for that intimate first-hand clinical instruction which can be secured only by placing the student in actual contact with the patient.

Some schools, as Pennsylvania, Hopkins and Jefferson, have already solved the problem by the establishment of their own hospitals. This is naturally the ideal course for all university schools and a future for which every school should plan. But in the absence of the possibility of im-

mediate consummation of such an ideal, results almost as satisfactory may be obtained by the actual affiliation of municipal or independent hospitals with the stronger medical schools. A hospital has as much to gain by this arrangement as has the medical school, for while the chief duty of the hospital must always be the care of the sick and injured, this duty, as well as its other functions—the instruction of men who are to practise medicine and the advancement of medical knowledge by research—is best served by placing the conduct of the hospital in the hands of men highly trained in the methods of scientific medicine.[15] This would not only enable the hospitals

> to fulfill a greater function in the development of thoroughly qualified physicians, but it would also be best for the patients, since they would have the benefit of the best methods of treatment under recognized experts. A campaign of education should be carried on to show our municipal authorities that the hospital will be the best conducted in the interests of its patients and the community at large, if at the same time it is fulfilling its function as a great center of clinical teaching and research.[16]

Many examples may be presented of the ideal association of charity, teaching and research as the results of such affiliation; the most striking perhaps being the magnificent clinic of Müller in Munich and the clinics of the University of Leipzig. Here, as in many other continental cities and in England, the university authorities by agreement with the municipal authorities appoint the heads of the hospital clinics. The long continuance of this arrangement and the great fame of most of these clinics is sufficient proof that both municipal authorities and university authorities find it mutually advantageous.

> We should bring about the same state of affairs in this country and, in fact, a start has already been made. At Cincinnati the large municipal hospital has been placed in charge of the clinical teachers of the University of Cincinnati; in St. Louis, the Washington University has made a close affiliation with the new Barnes Hospital; in Boston, Harvard has made an affiliation with the Peter Brigham and several other special hospitals; in New York, Columbia University and the Presbyterian Hospital have established similar relations; in Cleveland, Western Reserve University has formed a combination with the Lakeside Hospital; in Chicago, Rush Medical College has had for a number of years the medical control of the Presbyterian Hospital, and recently has made similar contracts and arrangements with the Children's Memorial Hospital, the Home for Destitute Crippled Children and the Hospital for Infectious Diseases.—Bevan.[17]

How much better such an arrangement would be than that which now exists. At present in most schools the clinical teacher is a teacher mainly because he is fortunate enough to control a hospital service, and for this reason has been appointed on the university staff. In his appointment the school has no choice, for it must have for its students the advantages of the clinical material which he controls. Whether he be good, bad or indifferent, as physician, teacher or investigator, he must be retained as long as he holds his hospital position. He, on the other hand, is handicapped by the regulations and restrictions of a not always sympathetic lay board of hospital management and, more important still, by the absence of proper laboratory facilities and the aid of his own colleagues in the departments of bacteriology, immunology, pathology and pathological chemistry. These departments are coming more and more into active participa-

[15] For a discussion of the advantages to be gained by the hospital, see Welch, W. H., "Advantages to a Charitable Hospital of Affiliation with a University Medical School," *The Survey*, XXVII., p. 1766, 1912.

[16] Bevan, A. D., "The Modern Medical School," *Jour. Am. Med. Asso.*, LVIII., p. 652, 1912.

[17] Bevan, *loc. cit.*

tion in hospital work, in diagnosis, prognosis and treatment, and should be as closely affiliated with the hospital as are the clinical chairs. Those of you who have read "The Corner of Harley Street,"[18] a most delightful series of letters by an English consultant, may remember the words quoted by the author from a lecture of a brother consultant to postgraduates. Said the lecturer:

Gentlemen, I should like the day to dawn when I could be met at the door of my hospital by a trained chemist, a trained bacteriologist, a trained pathologist, so that when I come to some complicated case I could say, "Chemist, a part of this problem is yours, take it and work it out. Bacteriologist, perform your share in elucidating this difficulty. Pathologist, advance, and do likewise."

These are not idle words. Since Ziemssen in the middle eighties established in Munich the principle of a clinical laboratory in the hospital, the idea has spread rapidly, until now every hospital worthy of the name has its clinical laboratory for the routine procedures of diagnosis. But this is not sufficient. The clinical chief must have the close cooperation of his colleagues in the departments of pathology, bacteriology, physiology and chemistry, and the student likewise must have the outfits of these departments at hand to aid him in his clinical studies. It is no longer enough to depend on the simpler procedures for the examination of urine, sputum, blood and other body secretions and fluids. The transportation across the city of tissues or fluids for examination in the laboratories of the school can no longer be countenanced. The progress of modern medicine, especially in pathological chemistry and immunology, demands for the benefit of the patient as well as for the proper instruction of the student, detailed and oftentimes prolonged examinations under the hospital roof or at least within the boundaries of the hospital yard, and under the control not of assistants or internes, or dependent on occasional visits of a professor of pathology, bacteriology or chemistry, but under the constant supervision of such experts who do their teaching and research in the hospital and contribute their share to the diagnosis, care and treatment of the ills of the patients. This is the ideal of social service in medicine, the goal of all effort in medical education and research; and it is not Utopian. Already the University of Toronto has transferred its departments of pathology, bacteriology and pathological chemistry to the grounds of the hospital which furnishes its clinical instruction. Here not only the elementary instruction is given, largely aided by an abundance of fresh material from the hospital, but each advanced student serving as clinical clerk in the wards has always his desk, well-equipped locker and special outfit for the detailed investigation of his clinical material by laboratory methods, and moreover, has always at hand his teachers in the laboratory branches to aid him in his clinical investigations. It was my good fortune recently to go over these departments with Professors Leathes and MacKenzie, who explained their workings to me. When I expressed my satisfaction at the ideal union of clinical and laboratory methods Professor Leathes said quietly, and as if there could be no other point of view, "Yes, we expect a student working in the wards to use in diagnosis the methods of pathological chemistry as he does his stethoscope." Do you know what this means? It means that the amphitheater clinic and the didactic lecture are to follow the two-year and three-year course and that the methods and instruction of the

[18] "The Corner of Harley Street, being some Familiar Correspondence of Peter Harding, M.D.," Houghton Mifflin Co., 1911.

laboratory years are no longer to be divorced from the clinical teaching of the later years of the curriculum. It means that men are to be trained by the "do it yourself" method to become practitioners with power of accurate diagnosis and the "mind which is prepared" to take advantage of every "chance" observation and opportunity. It means that the newer methods of biological, physical and chemical diagnosis, evolved through laboratory effort, are to work a transformation in medical teaching and medical practise analogous to that which came in the middle of the past century through the introduction of exact methods of physical examination. As physical diagnosis raised medicine above the plane of objective diagnosis and revealed the morphological changes in diseased organs of the interior of the body, so now the methods of physiological chemistry and immunology are destined to reveal the changes in the cells and fluids of the body which are dependent on intoxication, infection and altered metabolism and thus bring about an advance in methods of diagnosis, the fruits of which are almost beyond our powers of imagination.

Herein lies the most potent argument for close affiliation of school and hospital. The task, both from the teaching side and from the research side, demands united effort, common use of material and common financial responsibility. While any contract between university and hospital must leave the general support of the hospital in the hands of the hospital management, the school must be prepared to pay the salaries of attending staff, the cost of equipment and the expenses necessary for teaching and research and to assume the responsibility for the medical and surgical care of the patients and the general conduct of the scientific work. On the other hand, the hospital should leave the matter of appointments, subject to its nominal approval, entirely in the hands of the school, with the understanding that withdrawal or resignation from the school automatically would sever connection with the hospital, and *vice versa.* Such an arrangement settles most of the problems of medical education. Continuous service and freedom in the appointment of clinical teachers come as a matter of course. Teaching and investigation can be carried on without interruption. The student becomes a part of the hospital routine and is not an onlooker with limited privileges. The laboratory departments of the first and second years unite to aid the work of the clinicians in the hospital. Clinical teachers may be promoted, if deserving, or may be called from any part of the country, or from abroad; the choice no longer depends on local hospital appointments or on the selfish interests and friendships of local consultants, but on fitness, eminence and skill.

Teachers may be appointed on a university basis, devoting all or most of their time to the care of the patients, to teaching and to investigation. The heads of the departments of internal medicine and surgery certainly should be so appointed. Under such circumstances these men with their staffs could control a large body of students working relatively independently among the patients in the wards and in the special laboratories in or near the wards. In these clinical laboratories every student should have his own desk and outfit for microscopic, chemical and other methods of examination. Not merely apparatus for the simpler tests should be supplied, but as well every facility for prolonged bacteriologic examination, animal inoculation and detailed chemical and physiologic study.

Such a plan insures diagnostic ability and therapeutic skill by training the powers of direct observation as well as by instruction in the methods of indirect observation through the use of instruments of precision and the procedures of the chemical and biologic laboratories. The experimental method emphasized in the laboratory years is thus continued through the clinical years. Laboratory procedures naturally fall into their proper place in relation to the methods of direct observation, and as the student approaches each new disease in the spirit of the investigator and not as an onlooker he gains a point of view which can not fail to have an important bearing on his work as a practising physician.

The Hospital Year.—So much for the preparation which the training, facilities and opportunities of the modern medical school should offer as leading to the degree of doctor of medicine. Should the state and the public demand more? Yes, the state, through its machinery for the protection of the individual, should demand a fifth year of hospital work, and this the public would force the state to demand if the easy-going public was thoroughly familiar with the insufficient requirements of many of our state licensing boards. Indeed, some states are already drafting laws to protect their citizens from the products of the poor medical schools of a neighboring state—

> For example, the state of Minnesota has enacted a law enforcing an educational qualification as to the training of physicians who are allowed to practise in that state. The law was adopted in order to protect citizens of Minnesota against the graduate of commercial medical schools in neighboring states, and particularly of Chicago. In the present state of medical education such a measure is entirely justifiable.[19]

Such a law not only protects the community against the improperly prepared graduates of the poor school, but it encourages the good medical school to increased efforts.

The hospital year as a prerequisite to licensure is to-day a live topic of discussion; to-morrow it may be in this and in other states a requirement legally stated.[20] Indeed it is difficult to see how the progressive state of New York, the educational system of which is so wisely controlled by a special board of regents, can much longer delay in establishing such a requirement. But why wait for the regents to force this upon the schools? Already 80 to 90 per cent. of the men in the better schools secure hospital appointments. Why should not the schools compel the small minority of those who do not secure a hospital to take a fifth year in clinical instruction in the hospital which it controls and thus be prepared for the requirement which must inevitably come in this and other states. I realize fully that the deans of our various schools are divided on this question. Some take the position that although the hospital year is an excellent requirement, the burden of finding the hospital instruction for all its graduates should not be placed on the school; that the duty of the university is ended when it has given four years of instruction and that the fulfillment of the added requirement is an affair of the individual. What does this mean in the last

[19] Pritchett, H. S., "Education and the Nation," *The Atlantic Monthly*, April, 1912.

[20] There is only one school at present which requires the fifth hospital year, and that is the University of Minnesota. No state boards at present require the hospital interne year. Those which to a certain extent have initiated practical tests at their examinations are Massachusetts, Minnesota, Ohio and North Dakota, and to a lesser extent practical tests are being used in Colorado and Michigan. (Personal communication from N. P. Colwell, secretary, Council on Medical Education of the American Medical Association.)

analysis? Simply this, that a school holding this point of view is either lax in its entrance requirements or at fault in its methods of instruction; otherwise it would not fear the failure of its graduates to secure interneships. If this is true it has under the circumstances but one duty: as an educational institution, it must itself provide the fifth year of hospital work for its lame students. This is the point of view which is gradually forcing itself upon the school of the better grade, which, now that the pioneer stage of medical education is past, desires to itself complete the student's preparation, instead of turning him "over to others during this most valuable and important part of his preparatory work."[21] The proposition of Professor Peterson, of Michigan, that the council on medical education of the American Medical Association should conduct an inspection and classification of hospitals on the same basis as the inspection of medical schools is most timely. The data thus obtained would do much to clarify the situation, and, doubtless, mutual agreements between certain schools and certain hospitals of the same class could be reached as to the distribution of graduates for interne service. Such a systematization would allow school and hospital alike to see their defects and to so rearrange their work as properly to care for the greatest number of properly prepared men. Only through the hospital year can we give the best type of practitioners to a most deserving but too confiding public; but to bring about the consummation of this ideal every university school and every community possessing a modern hospital must do its share.

These general remarks cover, in my opinion, the cardinal principles which should guide the modern medical school. They can not, perhaps, in every community be enforced at once in their entirety, and doubtless now and then their adoption may be followed by backsliding, but no one who has given the subject serious thought can doubt that the future of medical education in this country depends on (1) the university school with a high entrance requirement, (2) instruction, in both laboratory and clinical branches, based on the method of observation and experiment, (3) clinical instruction in a hospital which the university owns or controls, (4) the principle of a fifth year of hospital instruction and (5) the fostering of the spirit of research.

And now finally let me congratulate Syracuse University on the high ideals it has set for itself in the conduct of its medical school. Your course has been watched by all who are interested in medical education. Your responsibility is greater than perhaps you realize; there are those praying for you to continue your present progressive system, others hoping you may fail. Each group desires to point to you as an object lesson. I have full confidence, however, that the wise trustees of your university, supported and encouraged by your alumni and the physicians of Syracuse and its surrounding territory, will not only maintain the present high standards, but will inaugurate still greater advances and thus ensure for the practitioner of medicine in this community the "prepared mind" of Pasteur's adage.

R. M. Pearce

[21] See Peterson, R., "The Relation of the Medical School to the Interne or Hospital Year," *Jour. Am. Med. Asso.*, LVIII., p. 723, 1912.

THE WORK OF COLONEL GORGAS

The degree of doctor of laws was conferred on Colonel W. A. Gorgas by the Johns Hopkins University on June 11. In presenting him for the degree Dr. William H. Welch said:

Mr. President: In behalf of the academic council I have the honor to present for the honorary degree of Doctor of Laws Dr. William Crawford Gorgas, colonel in the Medical Corps of the United States Army, member of the Isthmian Canal Commission and chief sanitary officer of the Isthmian Canal Zone, formerly president of the American Medical Association, physician and sanitarian of the highest eminence, who by his conquests over pestilential diseases has rendered signal service to his profession, to his country and to the world.

With high administrative capacity and with full command of the resources of sanitary science Colonel Gorgas has given to the world the most complete and impressive demonstration in medical history of the accuracy and the life-saving power of our knowledge concerning the causation and mode of spread of certain dreaded epidemic and endemic diseases. He it was who, by application of the discoveries of Major Reed and his colleagues of the Army Yellow Fever Commission, was mainly instrumental in freeing Cuba of yellow fever, and he it is who, in spite of obstacles and embarrassments, has made the construction of the Isthmian Canal possible without serious loss of life or incapacity from disease—a triumph of preventive medicine not surpassed in importance and significance by the achievements of the engineer.

In the conquests of science over disease, in the saving of untold thousands of human lives and human treasure, in the protection of our shores from the once ever-threatening scourge of yellow fever, in the reclamation to civilization of tropical lands—in results such as these are to be found the monuments of our laureate, his victories of peace, to which this university now pays tribute by such honor as it can bestow.

SCIENTIFIC NOTES AND NEWS

THE honorary degree of doctor of laws has been conferred by the University of Illinois on Vice-president Thomas J. Burrill and Comptroller Samuel W. Shattuck, both of whom retire at the end of the academic year after an active service of over forty years.

OXFORD UNIVERSITY has conferred its doctorate of science on Mr. A. P. Maudslay, president of the Royal Anthropological Institute of Great Britain and Ireland.

DR. E. RUTHERFORD, F.R.S., Langworthy professor of physics at Manchester, has been elected a corresponding member of the Imperial Academy of Sciences, Vienna.

DR. L. A. BAUER has been invited to deliver the Halley lecture on "Terrestrial Magnetism" at the University of Oxford, England, in May, 1913. He was elected a fellow of the American Academy of Arts and Sciences at the annual meeting in May.

AT the sixth annual meeting of the British Science Guild, held on May 17, a silver plate was presented to Sir Norman Lockyer, inscribed as follows: "Presented to Sir Norman Lockyer, K.C.B., LL.D., D.Sc., F.R.S., by members of the British Science Guild, on his seventy-sixth birthday, May 17, 1912, as a token of their esteem and as a recognition of his patriotic labors to promote the application of scientific principles to industrial and general purposes." Sir Norman was unfortunately prevented by ill-health from being present.

WE learn from *Nature* that Dr. D. H. Scott, F.R.S., president of the Linnean Society, has been elected a foreign member of the Royal Danish Academy of Sciences and Letters, and of the Royal Society of Sciences, Upsala.

IT is reported that Professor Lanfranchi, of the University of Parma, who has been engaged for several years in the study of sleeping sickness, has been infected by the disease in a severe form, and has been taken to the Pasteur Institute in Paris for treatment.

PROFESSOR MAYVILLE W. TWITCHELL, head of the department of geology in the University of South Carolina, has resigned to accept the position of assistant state geologist of New Jersey. He will reside in Trenton where he will take up his new duties early in July.

AT the meeting of the New York Section of the American Chemical Society, held on June 7, Professor Herbert R. Moody, of the College of the City of New York, was elected chairman of the section for the coming session to take the place of chairman-elect A. B. Lamb, who is going to Cambridge. The New York Section increased its membership over

a hundred during the past year, giving it a total of nearly a thousand members (962).

Edwin B. Frost, director of the Yerkes Observatory, has sailed for England and will probably remain in Europe until next spring. In his absence, correspondence for the Yerkes Observatory should be addressed to Mr. S. B. Barrett, *secretary*. The duties of managing editor of *The Astrophysical Journal* have been assumed by Professor Henry G. Gale, of the department of physics, University of Chicago.

Professor F. R. Moulton, of the University of Chicago, is sailing for Europe, where he will attend the International Congress of Mathematicians at Cambridge, England.

Professors R. Burton-Opitz and Frank H. Pike, of the department of physiology of Columbia University, have sailed for Europe. The former has a leave of absence until February, while Professor Pike will spend the summer abroad. Mr. Ernest L. Scott, of the University of Kansas, goes to Columbia as instructor in physiology.

Professor Francis H. Herrick, of Western Reserve University, will be absent on leave during the coming year in Europe.

Dr. Aleš Hrdlička, curator of the division of physical anthropology, U. S. National Museum, has gone to the Upper Yenisei region of Siberia, to carry on studies and collections for the museum and the California Exposition. From Upper Yenisei he will go to Irkutsk, and such other parts of Mongolia and Turkestan as he may have time to visit. After leaving Siberia he will visit Kiachtata in Chinese Turkestan, Mongolia, and then follow the road to Urga, whence he will proceed along the old caravan route to China proper.

Dr. Riley D. Moore, aid division of physical anthropology, U. S. National Museum, and Mr. John B. Harrington, ethnologist, of the School of American archeology, Santa Fé, New Mexico, will make a trip to St. Lawrence Island, Alaska, to make observations on the tribe of Eskimo which occupies that island. The data and material gathered are to be incorporated in the exhibits of the U. S. National Museum at the California Exposition in 1915.

Dr. D. B. MacMillan, of the Crocker Land Expedition, and Mr. A. C. Bent, of the Smithsonian Institution, have left in the power boat *George Borup* for the coast of Labrador on an ornithological and ethnological expedition. It has been erroneously announced in the newspapers that Mr. MacMillan has sailed for Crocker Land, the expedition to which will be undertaken next year.

The University of Illinois has celebrated the fiftieth anniversary of the passing of the Land Grant Act by unveiling the portrait of Jonathan B. Turner in the Illinois Farmers' Hall of Fame. President James in his commencement address on the Life and Labors of Professor Turner said: "All honor to Justin S. Morrill! But great as is the honor due to Mr. Morrill, the real credit for originating the plan incorporated in the Land Grant Act belongs to an Illinois farmer and professor, Jonathan B. Turner." The portrait of Professor Turner was presented by his daughter, Mary Turner Carriel, who was present as the guest of the university.

Major General E. R. Festing, F.R.S., known for his researches in physics and at one time director of the Science Museum, London, died on May 16, aged seventy-three years.

Mr. B. J. Austin, lecturer in physiology and hygiene at University College, Reading, and latterly emeritus professor of botany, died on June 2, aged eighty-three years.

The U. S. Civil Service Commission announces an examination on June 5, 1912, to fill a vacancy in the position of agricultural propagator in the Philippine Service, at a salary of $1,600 per annum, and of xylotomist, at $1,000 per annum, in the Forest Service, at Madison, Wis.

The annual meeting of the Swiss Association of the Natural Sciences will be held at Altdorf on September 9 and 10. A cordial

invitation is extended to American men of science to be present.

THE first International Congress of Comparative Pathology will be held in Paris, from October 17 to 22, under the presidency of Professor Roger.

THE proceedings of the International Radiotelegraphic Convention, at which thirty-five states are represented, were opened on June 4 at the Institution of Electrical Engineers, London.

INFORMATION has been transmitted to this government through the customary diplomatic channels, that the International Congress of Hydrology, Climatology and Geology, originally appointed to be held at Madrid from October 15 to 27 of the present year, has been postponed to the same dates (October 15 to 27), 1913. The participation of American scientists, scientific associations and higher institutions, is earnestly solicited by the Organizing Committee.

THE secretary of state for India has appointed a committee to inquire and report as to the facilities available for Indian students for industrial and technological training in Great Britain, with special reference to the system of state technical scholarships established by the government of India in 1904. The committee is constituted as follows: Sir Theodore Morison, K.C.I.E. (chairman), and Sir Krishna Gupta, K.C.S.I., members of the Council of India; Mr. J. H. Reynolds, M.Sc., lately principal of the Municipal School of Technology at Manchester, and Professor W. E. Dalby, M.A., professor of civil and mechanical engineering at the Imperial College of Science and Technology at South Kensington. The secretary of the committee is Mr. P. H. Dumbell, of the India Office.

THAT the forest cover of the White Mountains has a distinct and measurable effect upon the navigable streams which head in that region is the statement of the United States Geological Survey. The director of the survey has filed his preliminary report on the White Mountains with the National Forest Reservation Commission, and, as earlier announced, the findings are favorable to the purchase of lands under the Weeks law. The report is based on the results of investigations and specific field tests which have been carried on during the last year. While the survey has been subjected to criticism owing to its refusal to submit a perfunctory report assuming that a known and definite relation exists between forests and stream flow in the White Mountain region, the outcome of its investigations precludes the possibility of criticism by those who have opposed the acquisition by the government of any forest lands, on the theory that forest preservation does not affect stream flow. The hydrometric showing presented in the preliminary report covers results on two small, almost exactly similar drainage basins of about 5 square miles each, on the east branch of Pemigewasset River, one largely clothed with virgin timber and the other deforested and burned. Measurements of precipitation over the areas and of the run-off of the respective streams show that not only was the snow held better in the forested area, but that during a period of 17 days in April, including three extended storms, the run-off of the stream in the deforested area was a comparative flood—practically double that of the stream flowing through the forested area.

THE newspapers some weeks since contained the announcement of the discovery of a billion tons of iron ore in Fulton County, Pennsylvania, specifying red, brown and carbonate ores, ranging from 57 to 63 per cent. of iron, and found in Dickey's Mountain, Lowrie's Knob and the Meadow Ground. The geology of Fulton County is well known from the reports of the State Geological Surveys, and the impossibility of the case is apparent to any one who will read these reports and study the maps for a moment. A billion tons of iron would occupy a volume nearly equal to the mass of the three "mountains" named, and carbonate of iron when chemically pure contains only 48 per cent. of iron, and brown ore less than 60 per cent. Nevertheless, to ascertain what might have given rise to the reports, Director Smith, of the United States

Geological Survey, sent Geologist George H. Ashley into Fulton County to make an investigation. He reports that undoubtedly these hills contain several million tons of low-grade red iron ore and may contain a small amount of high-grade brown ore and more low-grade brown ore. Mr. Ashley found that three drill holes have been sunk into a shallow, canoe-shaped basin of red shale forming the "Meadow Ground." The basin is readily measured in length, breadth and depth. If all ore, it would hardly contain 30 million tons. The rocks are well exposed and show practically no iron except the iron coloring the rocks. Lowrie's Knob, if a solid hill of ore, would contain only about 100 million tons. The rocks here are likewise well exposed. A pocket of brown ore has been worked out on the east side by the old Hanover furnace, yielding about 75,000 tons of ore (46 per cent. iron). The "cove" fault runs through Lowrie's Knob and Dickey's Mountain, so that the rocks forming them stand on edge and locally are crumpled. Dickey's Mountain contains some low-grade sandy iron ore on the west side, possibly five million tons, as the bed cuts off against the fault. A little brown ore, 14 inches by 2 feet thick (38 per cent. iron), was dug for the Hanover furnace, but abandoned as impossible. The black shales of the Devonian are present in the region, but no suggestion of carbonate ore was seen.

A U. S. WEATHER BUREAU station has been installed at the University of Notre Dame, Notre Dame, Ind., by Mr. J. H. Armington, of the Chicago Station. Among the instruments located in the Science Hall, there is a triple register for wind velocity, wind direction, rainfall or sunshine as received on the roof by the anemometer, wind vane, tipping bucket rain gauge or sunshine recorder respectively. There are also two mercurial barometers and their barograph as well as complete equipment in the way of tables, record-books, report-books, etc., a few duplicate instruments and a snow gauge. There are on the roof, in a sheltered tower, wet and dry bulb, and maximum and minimum temperature thermometers with their thermograph. Professor Thomas A. Irvin, Ph.D., of the department of physics, has charge of this station which, in conjunction with the university observatory, posts on the Science Hall Bulletin complete daily reports of meteorological and astronomical observations.

SIR WILLIAM HARTLEY has presented to the University of Liverpool a wireless installation designed mainly with a view to experimental and research work of an advanced nature. For transmitting purposes a short aerial about 100 feet above ground has been erected on the roof of the electrical laboratory, and in connection with this a standard Marconi receiver has been arranged such as is used on board ship, and this combination forms a small standard power station. This has been licensed by the post office, and time and meteorological messages are received twice daily from the Eiffel Tower in Paris. The transmission range is only about 40 or 50 miles, save under very favorable conditions, as the post office regulations limit the amount of power that can be sent out of a station to one third horse-power. Professor Marchant, of the electrical engineering laboratories, is at present engaged in testing detectors, but later in the year he proposes to hold wireless classes for ships' captains and others interested.

UNIVERSITY AND EDUCATIONAL NEWS

MR. WALTER MORRISON, of Baliol College, has given $10,000 to Oxford University as the nucleus of a pension fund for professors.

J. CARLETON BELL, Ph.D. (Harvard), managing editor of the *Journal of Educational Psychology,* and director of the psychological laboratory in the Brooklyn Training School for Teachers, has been appointed professor of the art of teaching in the University of Texas. Dr. Bell will devote his attention chiefly to the experimental investigation of problems of teaching.

IN the College of Medicine of the University of Virginia, as we learn from the *Journal* of the American Medical Association, Dr. Jacob Michaux, one of the original members

of the faculty, resigned the chair of obstetrics and was made professor emeritus of obstetrics. Dr. Paulus A. Irving, who has moved to Farmville, Va., was made emeritus professor of pediatrics. Dr. John F. Winn, formerly professor of clinical obstetrics, was elected professor of obstetrics, and Dr. Virginius Harrison associate professor of the same branch. Dr. Francis W. Upshur was chosen professor of materia medica and therapeutics, and Dr. C. Howard Lewis was made professor of pharmacology and also associate professor of physiology, these two physicians dividing the chair which was formerly held by Dr. Virginius Harrison. Dr. E. C. L. Miller was elected professor of bacteriology and physiologic chemistry.

MR. HARRY N. EATON, A.M. (Harvard, '06), instructor in geology in the University of Pittsburgh, has been appointed assistant professor of geology in the Pennsylvania State College.

AT a recent meeting of the Yale Corporation, Jacob Parsons Schaeffer, M.D., Ph.D., was promoted from assistant professor to be professor of anatomy in the Yale Medical School.

NATHANIEL CORTLANDT CURTIS, professor of architecture in the Alabama Polytechnic Institute, has recently been elected to the chair of architecture in Tulane University of Louisiana.

E. S. MCCANDLISS, a graduate of Purdue University of the class of 1908, has been appointed instructor in civil engineering in the Missouri School of Mines.

PROFESSOR B. H. HIBBARD, of the Iowa State College, has been appointed associate professor of agricultural economics in the College of Agriculture of the University of Wisconsin.

FRANCIS E. LLOYD, for four years professor of botany in the Alabama Polytechnic Institute, and plant physiologist to the Alabama Experiment Station, has been appointed MacDonald professor of botany in McGill University. Professor Lloyd's address will remain unchanged till September 10 next.

DISCUSSION AND CORRESPONDENCE

THE DOME THEORY OF THE COASTAL PLAIN

TO THE EDITOR OF SCIENCE: Recently the writer's attention has been called to an article published in SCIENCE of April 5 by Mr. G. D. Harris in which he claims the entire credit for the discovery and promulgation of the "dome theory" of the accumulation of oil in the Gulf coastal plain. The statements in this paper are so misleading to those unfamiliar with the history of the development of this region, that the writer feels it necessary to state briefly some of the facts and to quote some of the geologists who were familiar with the early work.

The article in question is as follows:

OIL CONCENTRATION ABOUT SALT DOMES

In several national, state and private publications the writer has called attention to the remarkable concretionary growth and bodily movement upwards of huge masses of rock salt in Cenozoic deposits along the Gulf border. The bearing of the structures produced in the neighboring beds by such growths and movements on oil concentration was duly set forth in Bulletin 429 of the U. S. Geological Survey. Recently he has had the opportunity of testing the value of his "dome theory" for locating oil "pools" in a region far away from any known oil occurrences. Reference is here made to Pine Prairie, south central Louisiana, where the Myles Mineral Company has had the courage to try out the theory and has discovered by the means a new oil field. The director writes: "I consider this a most remarkable vindication of a theory originated by you, and we attribute a large measure of our success thus far to your advice."

Space should not be taken here to discuss the probable exact location of oil in connection with these domes; that is a matter depending largely on the approach of the salt domes to the surface, size, location, etc. These matters have been outlined at least in the U. S. Geological Bulletin already referred to. But the location of oil by means of a theory unheard of ten years ago does seem worthy of record at this time. Another fact that should be impressed upon the mind of the public now is the absolute worthlessness of stocks in companies putting down wells "near" the dis-

covery well. This matter has, however, been discussed in Bulletin 429.

G. D. Harris

Cornell University

At the risk of presenting a rather personal matter, the writer will briefly outline the history and cause of his investigations of the coastal plain region during the past eighteen years in search of deposits of mineral value. As early as 1894 he bored with diamond drills on Jefferson Island, Belle Isle, Weeks Island and Anse La Butte, La., discovering in each place a huge mass of rock salt of limited area but of great depth. At Jefferson Island pure rock salt was penetrated to a depth of twenty-one hundred (2,100) feet without finding bottom, and at Belle Isle rock salt, having a depth of twenty-seven hundred and forty (2,740) feet (pierced in 1907), was discovered with paraffine oil and large lenses of pure sulphur.[1]

The successful results attained by his explorations in Louisiana led the writer to extend the study of a nascent "dome theory" into Texas and to apply it to the various phenomena occurring on Spindle Top; a low elevation of only ten to twelve feet above the surrounding prairie, and to drill finally on this dome against the advice of his friends, with the well-known result that the largest well ever discovered in the United States and variously estimated at from 75,000 to 100,000 barrels per day had its birth on the tenth day of January, 1901.

The success of this well demonstrated the possibility of attaining economic results by drilling for oil, gas and sulphur on the domes of the coastal plain. This theory held good throughout the hundreds of wells drilled around Spindle Top in the effort to extend the area laterally without results, however, for it was subsequently proved that if the original well had been located only sixty-five feet further to the northwest there would not have been a discovery well.

[1] See "Rock Salt in Louisiana," by A. F. Lucas, in *Trans. Am. Inst. Min. Eng.*, 1899, also *Jour. Ind. and Eng. Chemistry*, Vol. 4, No. 2, February, 1912.

It must be noted that this well was not located on the axis of "the central dome," hence the great risk incurred in its drilling, and whoever may claim that this dome theory does not apply, and "fools" around the rim of the dome, stands a good chance to lose himself in the quagmires of gumbos and the unconsolidated sands with which the domes are surrounded. This was proved by hundreds of wells drilled around the Spindle Top dome, not in an effort to prove a theory, but rather in the strenuous effort to extend laterally the area of the productive territory. The dome theory as advanced by the writer in the early days of the Spindle Top field to Dr. C. Willard Hayes and Professor R. T. Hill, of the U. S. Geol. Survey, to Mr. Lee Hager, consulting geologist, Houston, Texas, Dr. Wm. B. Phillips, now director of the Mineral Survey, Austin, Texas, and to Mr. Eugene Coste, of the Canadian Mining Institute, has been generally accepted.

Mr. Hager, in a letter to the writer, dated May 27, 1912, from Houston, Texas, writes as follows:

> All of us down here, at least those who know the facts, are fully aware that the credit of first bringing the significance of these coastal domes to the attention of the world belongs solely to you, and I can not see that there has been any advance made upon your ideas even to this day.

Professor R. T. Hill, in the *Jour. of the Franklin Inst.*, Aug. and Oct., 1902, and in *Trans. Am. Inst. Min. Eng.*, Vol. 33, states:

> Before the discovery of Spindle Top there was only one man whose ideas—although not yet coordinated into a theory—approximately fitted the observed conditions. Of course I refer to Captain Lucas, who, in his explorations of the Coastal Plain, seeking successively salt, sulphur and oil, had observed the associations of oil, sulphur, sulphuretted hydrogen, gas, gypsum, dolomite and salt, constituting collectively what might be termed the oil-phenomena representing a group of secondary products as distinguished from the mother-strata or sediments out of which they have been produced. Moreover, so far as I am aware, he first pointed out the existence of anticlinal hills in the Coast Prairie and their connection with the oil-phenomena. . . . Captain Lucas early noted that

sulphuretted hydrogen escaping from the earth under certain conditions deposited sulphur in crevices near the surface. Such phenomena he observed at Spindle Top before commencing his well. At High Island, Galveston County, Texas, work was temporarily suspended on a well hole and the orifice stopped with hay in order to prevent obstructions from débris. Afterwards when the plug was withdrawn the hay was found to be imbedded in a matrix of sulphur, undoubtedly deposited by the escaping gas. . . . No topographic surveys have ever been made of any portion of the Coastal Prairie, and hence the slight irregularities of its contour are discernible only with difficulty. Until Captain Lucas's investigations, certain low elevations which have since become the most important features of the landscape were hardly noticed. I allude to low swells or hills, such as Spindle Top, which occur here and there and now attract attention from their supposed relation to the occurrence of oil beneath them. . . . In the generally monotonous monoclinal structure there are a few wrinkles or small swells likely to escape the eye of even the trained observer, and yet of a character which may have an important bearing on the oil problem. These are the circular or oval mounds already described which were first recognized by Captain Lucas. When he pointed out Spindle Top hill to me, my eye could hardly detect it, for it rises by gradual slope only ten feet above the surrounding prairie plains. I was still more incredulous when he insisted that this mound, only 200 acres in extent, was an uplifted dome. But Captain Lucas said that I would be convinced of the uplift if I could see Damon's mound in Brazoria County. In August, 1901, I visited that place and then returned for a second look at Spindle Top and was convinced that if these hills are not recent quaquaversal uplifts no other known hypothesis will explain them.

Mr. Marius R. Campbell, a later but impartial judge, in summing up the progress that had been made,[2] states:

In the general wave of oil explorations and development that swept over the country from the Appalachian region, when that was at the height of its production, oil was found at Corsicana, Tex., in flat-lying rocks that were similar in geologic structure to the rocks of the mid-continent field of Kansas, and it seems to have been generally assumed that there were no new problems in the oil fields of the Gulf coast. Captain A. F. Lucas, however, was not of this opinion. For years he had been exploring the salt beds of Louisana, and he appears to have been the first to fully appreciate the dome structure of such deposits, and to have been imbued with the idea that they contained not only salt and sulphur but also petroleum. His famous gusher on Spindle Top near Beaumont, Texas, struck oil January 10, 1901, and fully demonstrated the correctness of his theory, although this was not generally accepted by the geologists best acquainted with the field. Some endeavored to convince the public that the conditions at Spindle Top were similar to those at Corsicana, and that the pool would be found to have considerable lateral extent, but the oil drillers soon disproved this idea, and showed that oil was practically limited to the dome and small mound which constituted its topographical expression.

[2] *Economic Geology*, Vol. VI., No. 4, June, 1911.

There are scattered throughout the Texas Coastal Plain many well-known domes which have been prospected directly or indirectly by the writer, the most important of which are known as Saratoga, Sour Lake, Big Hill, High Island, Damon Mound, Keiser Mound, Barber Hill, Hoskins Mound, and Bryan Height. In the last-named mound the writer found in 1901 hydrogen sulphide under heavy pressure and also native sulphur which is now being heavily exploited by a New York syndicate, which hopes to make this equal to the sulphur mines of Louisiana. Whether or not this mound is also a salt dome remains to be proved by deeper drilling.

In conclusion it appears that the claim made by Mr. Harris in locating wells at Pine Prairie, as noted in his article in SCIENCE, quoted above, was quite premature, as *The Oil and Gas Journal*, of May 23, states:

Pine Prairie, that had promise of developing another Gulf coast field, has so far failed to produce other than disappointments. Of the five tests now drilling three are at depths considerably past that at which the Myles Mineral Company found pay in its No. 8, the discovery well, and have failed to drill into anything encouraging to test. The Producers Oil Company set screens in No. 1 Le Danois-Hudspeth at about 2,000 feet and made a try for a well, but the effort failed to be pro-

ductive, and as a result the pipe has been pulled out, broken down and the hole abandoned.

A. F. LUCAS

WASHINGTON, D. C.,
June 3, 1912

UNIVERSITY CONTROL

LETTERS FROM YALE UNIVERSITY

IT is quite unnecessary for me to speculate regarding what such a system as you propose would be. Exactly this system is in effect in New Haven. In fact Yale University consists of a collection of separate schools. Each has its own funds and almost complete autonomy. These funds are indeed held by the corporation and president, but in the main each department spends its income as its own judgment dictates with little interference from the university authorities. Each faculty nominates to the corporation its own new members, and as the corporation nearly always confirms nominations this amounts to election by the faculty. Each faculty elects its own dean who presides over its meetings. Its committees are either appointed by the dean (never by the president) or elected by the faculty itself. Such conditions fulfill almost exactly the suggestions of your pamphlet. The question is then: Does this system of university government attain the objects to which you look? I gather from your pamphlet and from previous articles of yours that the happiness of the professor is the principal object toward which you are striving. This is certainly achieved at Yale to a degree equalled, perhaps, nowhere else in America. Of course, satisfaction with one's position makes for loyalty and other incidental advantages; but is the happiness of the members of the faculty the principal object for which a university exists? Is not that form of university government best which provides the most ready adaptation of the university to the community which it serves? Ought not any form of university government to be judged by the degree of progressiveness of the institution having this government? I am inclined to believe from personal observation that in spite of all the advantages of democratic government which Yale enjoys—and which any university planned as you suggest would doubtless have—a more centralized control would make for great interdepartmental cooperation and a more ready adoption of new measures than is afforded by such democratic government. After all every institution inevitably adapts itself to the views of the masters whom it serves, that is, to those from whom it obtains funds. The state universities depend upon the people of the state, the endowed universities upon their alumni. It is an article of faith with every loyal alumnus that his alma mater is perfection. With a body of "loyal" alumni viewing every change with suspicion and with a faculty thoroughly satisfied with things as they are, there would not be under the system of government which you propose any sufficient machinery for the initiation of change. There are few—if any—of the endowed universities at least which would not in my opinion benefit enormously from having a Woodrow Wilson in the presidential chair. Certainly the one institution that has enjoyed this advantage failed to reap the full benefits therefrom, because the presidency carried with it too little power and the other elements in the university too much.

There are many things in the statement which are in harmony with my own views. I have always been, and still am, a strong believer in the desirability of autonomy for the individual schools or departments of a university. To-day our universities are so large and so complex in character that it is impossible to have adequate control over all the varied interests of the university in the hands of a central body. I believe in the desirability of a corporation, or board of trustees, in whom rests final authority for all matters pertaining to the university; but I think that the initiative, the control and the general management of a department or school of the university should rest in a governing board or subcommittee, whatever you choose to call it—with a chairman or dean or director, who is given, subject to said board, a large measure of authority. The corporation of the university should be representative of all the interests of the university, so far as possible. Here at

Yale, where alumni representation is perhaps as strong as in any university, we have been reaching out of late years further and further, so that to-day we have on our corporation various men elected from the alumni; but in addition we have what is called an alumni advisory board, a body composed of representative alumni from all over the country; but while having no real authority, they are able after discussion among themselves to present to the corporation suggestions and advice, sometimes of great value. This, no doubt, is a move in the right direction. I have advocated, however, what I see you advise here, the desirability of a movement in the other direction, namely, of closer relationship between the corporation and the professors or other officers of the university. At present, in most institutions, if not in all, the president is the sole person on the board of trustees or on the corporation who is supposed to be in touch with the activities of the faculty or faculties. At present, however, with the large size of the university, the president does not have, and can not necessarily have, an intimate knowledge of what is going on. I believe, therefore, very thoroughly in the idea of direct or indirect representation on the corporation of the university of the faculty in the persons of say three professors, who might sometimes be the deans of the individual departments. In your third paragraph regarding the unit of organization within the university, you have outlined exactly what we have in force here. Thus, in the Sheffield Scientific School, the scientific department of Yale, our governing board, composed of permanent professors, about twenty-four in number, is the deliberative and active body, subject of course to the corporation. The size of this group is such that it is thoroughly efficient. Your fourth paragraph is likewise in harmony with our customs and our beliefs in the Sheffield Scientific School. The director is elected every five years. He is given a large measure of authority, but all the same he is subject to the governing board of the school, and there is a very distinct autonomy. Professors and assistant professors, and indeed instructors, are all selected by the governing board, or in practise by committees appointed by the governing board, subject to their approval. Nominations then go from the governing board to the corporation for confirmation. Regarding the salaries, personally I am a strong believer of having the salary the same for all officers of the same grade, subject possibly to advances on the basis of years of service.

(1) Approved, except that the treasurer should be responsible to the president, as otherwise he could hamper the actions of the president by lack of financial support. (2) The professors should elect the president to continue in office at the pleasure of the trustees and removable only by the trustees. I think his salary should be larger and his position more dignified. I do not believe in electing an executive officer and then not letting him execute. The present autocratic attitude of certain presidents would tend to be limited if they were elected by the professors and the professors were able to remonstrate to the trustees; but it is equally clear that the efficiency of the president should not be hampered by the necessity of keeping in favor with all the professors. (3) Approved. (4) There is danger of professors being required to waste too much time in executive work and keeping to themselves powers which should be delegated to executive officers. I think the president should assume the burden of finding candidates, weighing their qualifications, deciding what positions should be filled; but he should do this in consultation with committees of the professors and his action in regard to all appointments should be ratified by faculty vote. (5) The idea of general faculty meetings at occasional intervals is a good one, though as you state not much business can be transacted in such a large body. In conclusion, I would differ from the plan outlined in conferring more working power on the executive officers and leaving the professors free for teaching and research, but at the same time make the executive officers responsible to the faculty as well as to the trustees.

On the whole I think I approve of the policy you set forth. There are minor details I should wish to consider more. You know that to a very considerable degree what you advocate is the plan at Yale University. Our departments and notably this school are in great measure autonomous. It seems to work well here. It has long been a question in my own mind if a unit of 1,000 students with the necessary instructors, buildings and equipment was not as large a one as could be handled by one man as president, dean, director or what you will to obtain maximum efficiency. This in a way seems to be the army view of it, where the regiment of about this magnitude of unit has its colonel. The kind of management that a colonel must give is what I think one should expect (the difference between the two affairs being properly considered) from a dean or director. I mean that personal supervision of matters that comes of personal knowledge. And when the university is 5,000 in size the president would do well to become a general.

I think you are correct in believing that our universities need remodeling. We have a democracy here at Yale and yet the most effective administration is in the Sheffield Scientific School, where democracy and autocracy are combined. After all administrative heads must have power to act and a good administrator does not work well hedged in by all sorts of limitations. It takes the snap out of one to work under restrictions. The more I see of democracies, the more I come to believe in a limited monarchy.

The more I see of university management the more I feel in a cloud as to what is the best thing. At the present time I haven't any definite opinions on the subject. All I can say is that to me the question of the actual formulation of rules to govern a university is much less likely to have a real influence than the spirit and ideas of the people connected with the university. I can not help thinking that the latter will be the dominant factor, whatever organization may be laid down.

I thoroughly agree with the proposed plans (3), (4), (5), in their essential details. Your views on these points are, I believe, correct. With regard to (2) my reply would depend somewhat on the interpretation of your words. The expression "expert knowledge of education" is the point at issue. Our college and university presidents ought in many cases to talk less and become more familiar with the men, *i. e.*, teaching staff and their work. I am not at all certain that your further suggestions under (2) are expedient. Suggestion (1) does not appeal to me as presented. I do not believe in extreme democracy. However, I prefer to omit discussion of this point, as I have never given any serious thought to it.

I do not wish to be drawn into the discussion. I wish to tell you, however, that I heartily approve of the policy of Science to air the university situation. Its fearless attitude is very needful, in my humble opinion.

I am in accord with the general principles. At the present time the president of most American universities is "neither fish nor flesh nor good red herring." He is so overburdened with administrative duties that he is unable to inform himself as to the educational aspects of the different departments of the university. I speak feelingly on this point because I have been more or less intimately connected with several university medical departments, and it has been my experience that university presidents need about as much education on the subject of medical schools as ordinary intelligent laymen. I dare say the same is true of law and divinity schools, etc. I do not mean to deny that there are brilliant exceptions to this general statement. I am therefore very strongly in favor of the division of the work now accomplished by university presidents into an executive portion, to be taken care of by a chancellor or some similar officer and a board of trustees, and an educational portion, to be overseen by a trained educator. When you come to think the matter over there are singularly few col-

lege presidents who hold that position on account of special training. I agree also as to the unit of organization consisting of the school or department, that being the natural and logical unit. I also agree in the main with the machinery proposed in paragraph (4). The only inadvisable thing, to my mind, would be the constitution of a permanent board of advisers—if you mean it to be permanent. I would add that it might be wise to set a time limit upon the deanships—or directorships—whatever you care to call them. Personally, I doubt very seriously whether a single individual should be the controlling force in a department for more than ten years. Your fifth section, which proposes the senate and the plenums, I think is also desirable. I assume that this senate and the plenums would legislate regarding the educational policy rather than regarding the financial policy.

I heartily approve of your scheme for university control. In our university, as in others, the head of a department has altogether too much power—or uses it too arbitrarily. In fact, members of the faculty scarcely dare to oppose his plans or to vote against his reelection, for fear of reprisals, unjust discriminations, etc. Thus a president or head of a department may become a sort of dictator, or like a political "boss."

Your reprint is a very moderate statement of the evils arising from the present system of college and university control. The worst of these evils is probably its discouraging and deterrent effect upon the men exercising the teaching functions in this class of institutions. And if this system continues without essential modifications, this form of its evil results is likely to grow with constantly accelerating rapidity. Self-respecting and gifted and independent men will not choose a career which may at any time be cut short or even totally ruined by the caprices of a presidential "boss." For myself, and much as I love and highly as I prize the office of the teacher, I should hesitate long before accepting, were I again young and asked, under the changed conditions, to enter the life of a college or university professor. As in all similar cases, the remedy is by no means so clear as are the evils demanding a remedy. I am inclined to think that the details of any change of plan would need to differ in different institutions. Certainly they could not be precisely the same for the private and the state institution. And in both cases, care would not be of small importance to avoid changing the benevolent despot for the uncontrolled mob. It would seem also that some means should be devised for placing the control of instruction and the control of finances in largely different hands, while securing frank and cordial intercourse between the two.

SCIENTIFIC BOOKS

The Biology of the Seasons. By J. ARTHUR THOMSON. Illustrated by WILLIAM SMITH. New York, Henry Holt and Company. 1911.

The Natural History and Antiquities of Selborne, in the County of Southampton. By GILBERT WHITE. With illustrations in color by GEORGE EDWARD COLLINS, R.B.A. London, Macmillan & Company. 1911.

It is worth while to consider these two books together, for resemblances and contrasts. They are typical of the centuries to which they belong, of the old and the new in natural history. Professor Thomson points this out, in his introductory chapter. "The older naturalists—before Darwin's day—made many careful pictures of the life of plants and animals as it is lived in nature. The indefatigable patience, the keen observation and the sympathetic insight of many of these pre-Darwinian naturalists must remain as models to which in these later days, with improved methods, we try to approximate. Gilbert White's 'Selborne,' above all, remains evergreen. But the old records are for the most part contributions to Natural History rather than to Biology. To most of their authors there was wanting the biological key which Darwin first taught men to use." But in post-Darwinian writings "biological ideas have become dominant; analysis has become more penetrating; the pictures have a broader

perspective and a deeper insight." In the books before us, however, there is a contrast in the attitude toward the reader as well as toward the subject. Listen to Gilbert White: "If the writer should at all appear to have induced any of his readers to pay a more ready attention to the wonders of the Creation, too frequently overlooked as common occurrences; or if he should by any means, through his researches, have lent a helping hand towards the enlargement of the boundaries of historical and topographical knowledge; or if he should have thrown some small light upon ancient customs and manners, and especially on those that were monastic, his purpose will be fully answered." Simplicity and humility enough, but the offering consists of his own "researches," presented in the hope of somewhat enlarging the bounds of human knowledge. Now Professor Thomson: "That the method of seasonal biological study is educationally sound is best proved by experiment. But it is perhaps enough to ask the simple question: *What kind of scientific lore concerning living creatures would we most naturally teach our children in spring?*" The attitude is pedagogical throughout: the author has come to instruct—as pleasantly and interestingly as may be, but never forgetting that he is a teacher. The book does not set forth the "researches" of the writer, or, if doing so, makes little of them; it is a contribution to pedagogy, based on compiled materials of every kind. There is nothing of the artless art of Gilbert White, nor indeed (in spite of Selbornian imitators) is such a thing quite possible in this sophisticated age.

All things considered, Professor Thomson's book is a charming example of popular scientific writing, and we would recommend it to those who have some knowledge of the matters whereof it treats. The other day I took occasion to read one of the chapters (The Tale of Tadpoles) to a large university class in biology, and in so doing came to highly appreciate its merits, and at the same time notice what seemed to be its faults. It is extremely suggestive, so that all along the line one is tempted to interject new arguments and facts. The whole book is just a little uncritical, the author having a field so wide that he can not quite master all the details, so that at times he takes little doubtful data on trust, and at others is perhaps led somewhat astray by his own rhetoric. This must be the fate of all popular writers and teachers, indeed of all university professors. As one of our most brilliant researchers and teachers put it in conversation recently, there is always this dilemma: if you make yourself quite clear and strive to be perfectly logical, you do it at the expense of some of the truth, because in dealing with biological matters you are never really free from difficulties and uncertainties. If you go to the other extreme, you merely produce confusion. Substantially, the method so excellently typified by Professor Thomson's writings is abundantly justified and sufficiently accurate, but critical readers will always wish that some things had been stated rather differently.

Another fault in the book reviewed is, I think, an undue tendency to use words which are not likely to be understood by the general reader. Even in the reading just mentioned, to a more or less instructed class, I found myself frequently translating. Against this objection must be set the undeniable fact that the author's rich vocabulary enables him to state things more accurately and briefly than would be possible were he to use only the poor English of the street.

There still remains the question whether popular science, as presented to-day by Professor Thomson and a number of other eminent men, has not swung too far away from the standpoint of Gilbert White. Is there not some danger of becoming too professional, too pedagogical? Is it too much to say that we can not have a real diffusion of culture in these matters until we have more of the spirit of the amateur?

The new edition of "Selborne" has a most attractive appearance. It is reprinted from the original without any alterations or annotations; there is not even an editorial note. The numerous colored plates are pleasing, yet I think not wholly satisfactory. In many the

outlines are too hard and the colors not quite true; there is too much of the mannerism of the artist. The colored plates in Professor Thomson's book also seem to me criticizable; they look a little out of focus, as it were—much as things look to the present writer when he has mislaid his glasses.

On the chance that some of our active workers in genetics have not recently read their "Selborne," it may be worth while to quote the following pertinent information: "One thing is very remarkable as to the sheep: from the westward till you get to the river Adur all the flocks have horns, and smooth white faces, and white legs; and a hornless sheep is rarely to be seen: but as soon as you pass that river eastward, and mount Beeding-hill, all the flocks at once become hornless, or, as they call them, poll-sheep; and have moreover black faces with a white tuft of wool on their foreheads, and speckled and spotted legs: so that you would think that the flocks of Laban were pasturing on one side of the stream, and the variegated breed of his son-in-law Jacob were cantoned along on the other. And this diversity holds good respectively on each side from the valley of Bramber and Beeding to the eastward, and westward all the whole length of the downs. If you talk with the shepherds on this subject, they tell you that the case has been so from time immemorial, and smile at your simplicity if you ask them whether the situation of these two different breeds might not be reversed. However, an intelligent friend of mine near Chichester is determined to try the experiment; and has this autumn [1773], at the hazard of being laughed at, introduced a parcel of black-faced hornless rams among his horned western ewes. The black-faced poll-sheep have the shortest legs and the finest wool."

T. D. A. Cockerell
University of Colorado

THE HINDU-ARABIC NUMERALS

In a recent number of Science[1] I ventured to assert the correctness of the statement that our present decimal place system with the zero is of Hindu origin. The veteran historian of mathematics, Moritz Cantor, makes substantially the same assertion in the latest edition (1907) of the first volume of his "Vorlesungen über Geschichte der Mathematik," p. 608. He says, referring to the use of words with place value.[2]

> This kind of conscious juggling with the notions of positional arithmetic together with the zero, is most easily explained in the home of these notions, which (home) for us is India and this we may affirm even if there is question of a second home. We mean if both notions were born in Babylon, of which there is great probability, and were carried over into India in a very undeveloped state.

We may add that neither Cantor nor any other has yet presented any historical evidence that these ideas were carried over to India from Babylon. Eneström, the editor of the *Bibliotheca Mathematica*, a journal devoted to the history of mathematics, has recently[3] supported the view that the Babylonian arithmetic is not of the same nature as our system. The Babylonians did not use the zero, so far as we know, with the same notion of place value for purposes of computation as in the Hindu system. The Babylonian multiplication tables published by Hilprecht which include tables of 1,800 times various numbers are an evidence of this fact. In a fully developed sexagesimal (60) system this table would be replaced by the table of thirty times the corresponding numbers, since 1,800 equals 30 times the unit of higher order, 60. Furthermore, the Babylonian system was not adapted for computation because of the mixture of decimal and sexagesimal systems and further because of the large base, 60.

Recently another early document referring to the Hindu numerals has been published. This document is of prime importance because, being written in 662 A.D., it antedates by more than two centuries the earliest known appearance in the ninth century of the numerals in Europe. The probability is, too, that the

[1] January 5, 1912.

[2] See Smith-Karpinski, "The Hindu-Arabic Numerals," p. 39, for an explanation of this system.

[3] *Bibliotheca Mathematica*, Vol. XI. (3), 1911, p. 331.

numerals were fully developed in India not much more than two centuries before this time. We are thus brought very close to the time of the origin of the powerful symbols which we use for computation. Further, the passage is of interest because it explicitly mentions the Babylonian contributions to astronomy and we must conclude that if the writer at that early date had known of any connection between the Babylonian number system and the Hindu he would have mentioned it. The passage in question is presented by M. F. Nau in some notes on Syrian astronomy.[4] M. Nau quotes from the writings of one Severus Sebokt, bishop of the monastery at Quennesra, on the Euphrates, near Diarbekr. This Sebokt was famous in a literary way and made his monastery a center of Greek learning. He himself was originally from Nisibin towards India, and it is not beyond the bounds of probability that there he came into contact with the learning of the Hindus.

Sebokt claimed for the Syrians the invention of astronomy. He stated that the Greeks went to school to the Chaldeans of Babylonia and these, he adds, are Syrians. This statement of Sebokt's is supported by the most recent investigations in the history of the development of science. An interesting article on this subject was published by F. Cumont, entitled "Babylon und die griechische Astronomie."[5] Sebokt concludes that science is not the peculiar property of the Greeks, but rather open to all men.

The subsequent passage contains the reference to the numerals and I translate from the French translation given by M. Nau:

> I omit now to speak of the science of the Hindus, who are not Syrians, of their subtle discoveries in this science of astronomy—(discoveries) which are more ingenious than those of the Greeks and even of the Babylonians—and of the easy method of their calculations and of their computation which surpasses words. I mean that made with nine symbols. If those who believe that they have arrived at the limits of science because they speak Greek had known these things, they might perhaps have been persuaded, even though a little late, that there are others who know something, not only the Greeks, but even people of a different language.

[4] *Journal asiatique*, Vol. 16 (10th series), 1910, pp. 225–227.

[5] *Neue Jahrbücher f. das klass. Altertum, Gesch. und deutsche Literatur und f. Pädagogik*, 1911, Vol. 27–28, pp. 1–10.

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SPECIAL ARTICLES

THE SOURCE OF THE CURRENT OF INJURY

When we connect calomel electrodes filled with KCl solutions of the same concentration with the uninjured skin and an injured spot of an apple, respectively, we notice a potential difference from between 40 to 100 millivolts, the injured spot of the apple being negative to the uninjured spot. We have made experiments which indicate that the so-called current of injury is due to a difference of potential which exists on the inside of the skin of the apple probably at the limit between the skin and an adjacent layer of cells, the latter being negative to the former. The proof for this statement is found in the following facts.

1. When we form a cell of the type

$n/10$ KCl uninjured side	Apple	$n/10$ KCl injured side

the E.M.F. remains the same no matter how deep a hole we make into the apple. As soon, however, as the $n/10$ KCl approaches the inner surface of the apple the E.M.F. suddenly becomes smaller and finally disappears.

This is not due to an injury of the skin itself, since a change in the concentration on the outer surface of the skin still gives the same change in E.M.F. as in an intact apple. The disappearance of the "current of injury" when the salt solution reaches the inner surface of the membrane of the apple is therefore due to the disarrangement or destruction of a specific layer on the inside of the surface film of the apple.

2. By pressing the surface of an apple with a finger we can destroy the adjacent layer on the inside of the skin without injuring the

latter. This can again be proved by measuring the influence of the change of concentration of a salt solution on that outer surface, which is exactly the same as it was before the pressure was applied. If, however, we connect this part of the skin and an intact part of the skin with a pair of calomel electrodes filled with a KCl solution of the same concentration, we get an E.M.F. of the same order of magnitude and the same sign, as if the skin at the pressed spot had been removed. This experiment, which is very striking, indicates also that the current of injury is due to the existence of a potential difference at the inner surface of the skin of the apple which depends upon the integrity of a definite structure.

3. An attempt to account for the nature of this E.M.F. led to the discovery that salts and acid, if applied in the same concentration to the outside surface of an apple, give rise to differences of potential of the same order of magnitude as found in the current of injury. The E.M.F. of the cell

$n/10$ NaCl | uninjured apple | $n/1,000$ NaCl | $n/10$ NaCl (I.)

is greater than that of the following cell

$n/10$ NaCl | uninjured apple | $n/1,000$ HCl | $n/10$ NaCl (II.)

In (I.) the E.M.F. was .088 volt, in (II.) .038 volt.

4. Since this difference is of the order of magnitude of that found in the current of injury, it was natural to test the action of the juice pressed out of the apple. Its conductivity was found to be $K_{18}o = .00226$. This would correspond to a concentration of $n/58$ if the electrolyte contained in the sap were KCl, or $n/170$ if it were HCl. The apple juice contains a considerable amount of malic acid. Nevertheless it does not have the negative effect characteristic of the acid. If the negative potential on the inside of the skin is due to a layer of acid it must differ in its action from the sap pressed out from the apple.

These experiments indicate that the current of injury of the apple is due to a potential difference at the inner limit of the skin or membrane; and that this potential difference depends upon the integrity of a preformed structure. This structure may give rise to the formation of a film of an acid but this is hypothetical.

Our observations prove that Hermann's alteration theory of the current of injury can not be correct. This theory assumes that the difference of potential exists at the injured surface, while the experiments mentioned here show that the seat of the potential difference is, at least for the apple, not at the seat of the lesion, but at the inner limit of the intact skin or membrane and its intact adjacent layer. DuBois's preformation theory is confirmed, although in a different form from that which this author suggested.

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SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 498th regular meeting of the society was held in the assembly hall of the Cosmos Club on April 13, 1912, with President Nelson in the chair.

Under the head of General Notes, Dr. B. W. Evermann exhibited dyed and undyed skins of fur seals from the Pribilof Islands, and made remarks on the commercial classification of skins and on the aims of the Bureau of Fisheries regarding the fur-seal industry.

The paper of the evening was by Mr. Chas. Sheldon on "Winter Animal Life about the Base of Mt. McKinley." Mr. Sheldon gave an interesting account of his experiences with the birds and mammals of the Mt. McKinley region during the winter of 1907–08, describing in detail the food and habits of the Alaska jays, the mallard ducks, which were found wintering where local conditions favored open water and sufficient food, the lynx, conies, foxes, caribou, moose and sheep. Mr. Sheldon's lecture was admirably illustrated with numerous lantern slides, showing his cabin, general and detailed views of the country and long- and short-range snap shots of all the larger animals of the region.

THE 499th regular meeting of the society was held in the assembly hall of the Cosmos Club on

April 27, 1912, with President Nelson in the chair. Three papers were presented:

Are Rabbits Rodents? J. W. Gidley. (To appear in Science shortly.)

Remarks on the Skeleton of the Dinosaur, Stegosaurus: C. W. Gilmore.

The type specimen of *Stegosaurus stenops* Marsh in the U. S. National Museum is the most complete skeleton of the genus that has yet been discovered, and the recent assembling of the large blocks of sandstone which contain this fossil enabled Mr. Gilmore to discuss several points in its anatomy. Especially attention was given to the position and arrangement of the elements which comprise the dermal armor, and since this is the only individual known which gives anything like a true idea of the manner in which the armor was attached the importance of the specimen is at once apparent.

It was pointed out that there was a great diversity of opinion among vertebrate paleontologists, especially regarding the number and arrangement of the plates and spines constituting the exoskeleton. Marsh in 1891 made the first pictorial restoration of *Stegosaurus* and placed the series of flat plates (12 in number) in a single row along the median line of the neck, back and tail, with four pairs of spike-like spines near the end of the tail. Lucas in 1901 published the next restoration, and was the first to show the plates (28 in number) arranged in pairs. Later in a statement prepared under his direction the plates of opposite rows (22 in number) were made to alternate, and the spines were reduced from four to two pairs. The latest conception, as exemplified by a recently mounted skeleton in the Peabody Museum of Yale University, shows a return to the paired arrangement of the plates (28 in number) and the retention of four pairs of spines.

It was shown that specimens in the National Museum corroborated most conclusively Lucas's second interpretation, and with the exception of one or two points is entirely in accord with the evidence.

That the plates of opposite rows did alternate is shown by the way they lay embedded in the rock, and that no two of them were precisely similar in shape or dimensions.

It was demonstrated that the usual number of spike-like spines is two pairs, as shown by seven individuals, six of which are in the National Museum.

The facts relating to the dermal armor which now appear to be established from this preliminary study are:

1. That the armor of the neck, back and tail was found by two rows of erect plates, the elements of one row alternating with those of the other.

2. That the total number of plates in the two rows was not less than 22.

3. That the position of the largest plate of the series appears to be above the base of the tail, and not over the pelvis.

4. That the usual number of dermal spines on the tail is 4, arranged in two pairs.

Early Bird Migration in a Late Spring at Washington, D. C., 1912: Wells W. Cooke.

The winter of 1911–12 was the coldest at Washington, D. C., for many years, and yet several species, notably the robin, were more common than usual, due to unusually warm weather in December.

January, February and March to the 27th were far below the normal, and yet about half of the species of birds that arrived during this period were earlier than their average date. When, however, these species were examined more carefully, it was found that those who arrived early were all species that occasionally winter as far north as Washington, and these early migrants undoubtedly represent individuals that had spent the winter in the heavily forested swamps and had been observed when they returned to open country.

The rest of the species that arrived late during this cold period were all birds that winter far to the south of Washington.

On March 28 the weather turned warm and remained above normal for a whole month. Immediately birds began to arrive from the far south that were decidedly ahead of their normal date, and in the case of some of them, earlier than the earliest previous date. This is one of the best examples of what usually happens when a cold spell begins to break. The cold had been widespread, holding the birds far south, and when the warm spell began the birds rushed north and continued their flight longer than usual until they were actually ahead of their schedule time.

Almost every species for the whole of the rest of the migratory season of 1912 at Washington, D. C., arrived earlier than their average dates.

M. W. Lyon, Jr.,
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